



Water and More

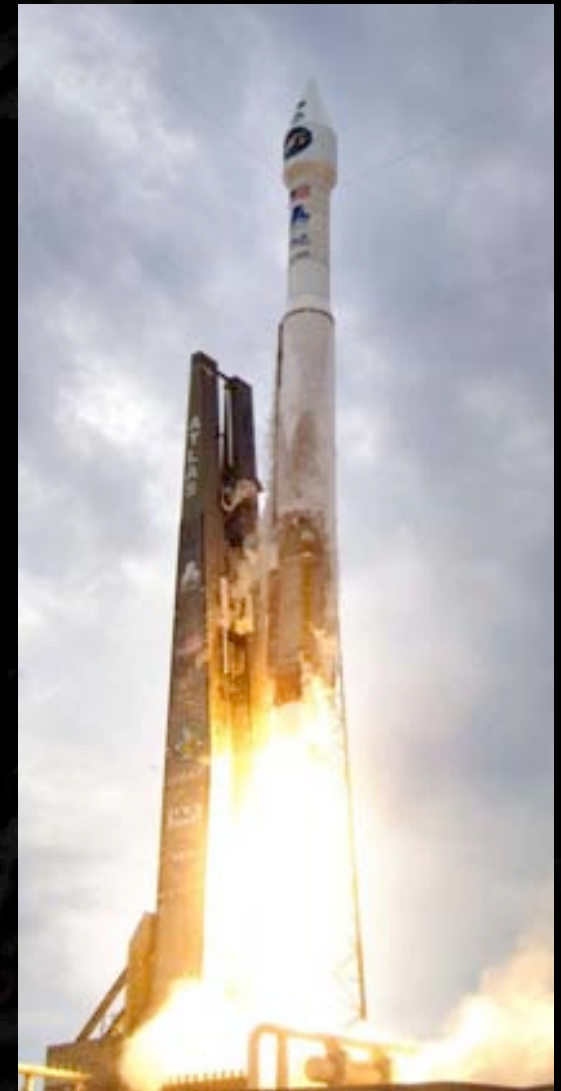
An Overview of LCROSS Impact Results

Anthony Colaprete and the LCROSS Team
NLSI July 20, 2010



Summary of the LCROSS Experiment

- On October 9, 2009 the Centaur (2300 kg) impacted at 2500 km/sec, right on target, inside of Cabeus
 - Used four-month cruise to bake-out and “decontaminate” Centaur
- Impact observed by an armada of observatories
 - Two best seats in the house were LCROSS
 - Shepherding SC and LRO
 - Final impact site and 10 cm of terrestrial water (over Hawaii) made Ground-based observations difficult
 - Several observations of sodium (e.g., Killen et al., 2010) and possibly OH (Storrs & Colaprete, 2010) were made





Summary of the LCROSS Experiment

- LCROSS observed the impact “Flash”, “Curtain” and “Crater”
- Even before impact LCROSS had indication of what lay below
 - An exosphere of Mg, Na, and possibly CO and OH detected just above the crater
- After impact, the first detection was a thermal flash and a hot (1000 K) vapor cloud racing from the crater
 - Gas contained H_2 , Hg, Na, and OH
- Next followed two ejecta curtains:
 - 1) a low angle plume that raced radially at ~ 1 km/s
 - 2) a high angle plume that reach ~ 15 km height
- During four minute descent LCROSS detected a variety of compounds including water ice, OH, H_2S , SO_2 , CO_2 , H_2 , CH_3OH , and CH_4

The LCROSS SC

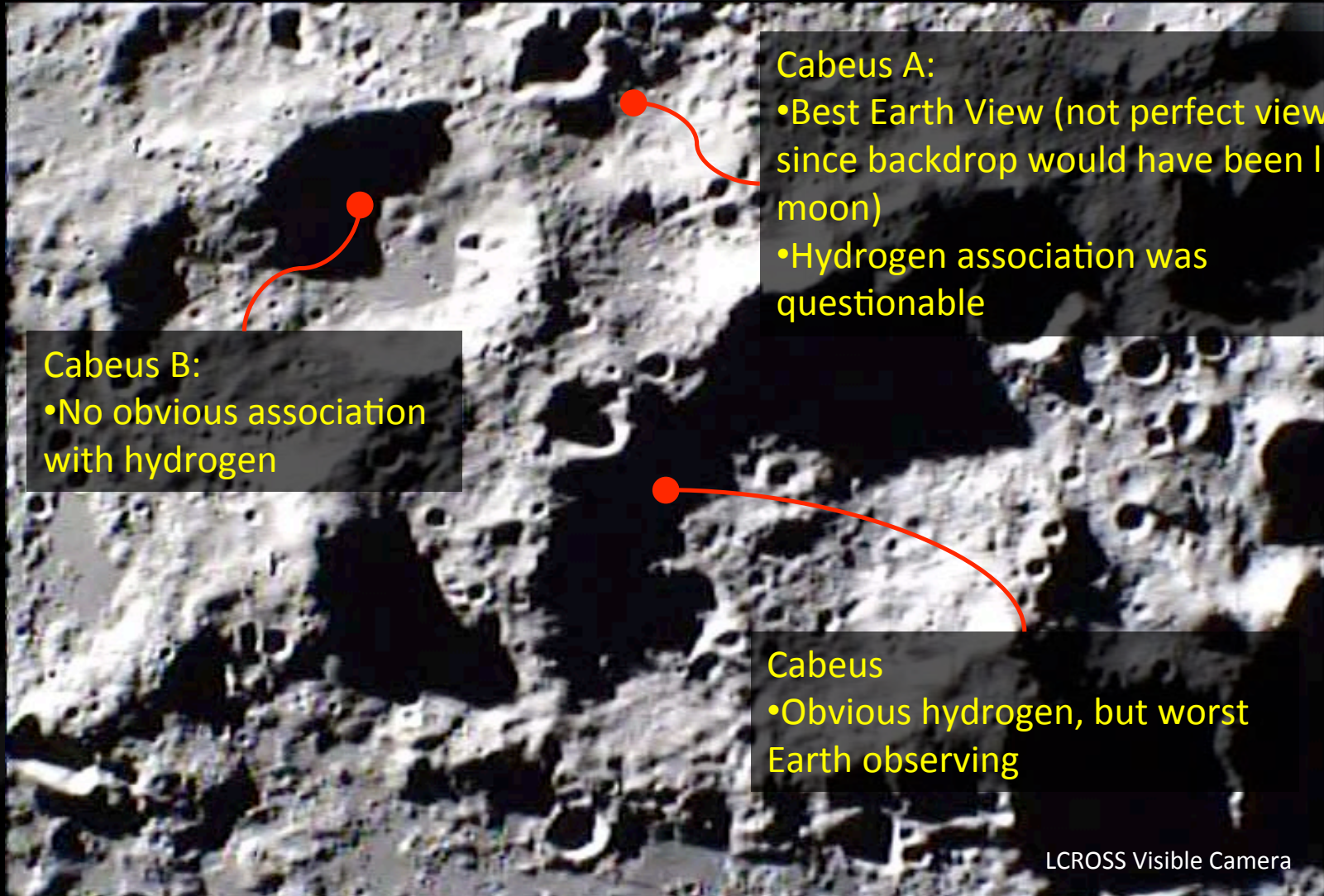


The LCROSS Payload





The Final Target



Cabeus B:

- No obvious association with hydrogen

Cabeus A:

- Best Earth View (not perfect viewing since backdrop would have been lit moon)
- Hydrogen association was questionable

Cabeus

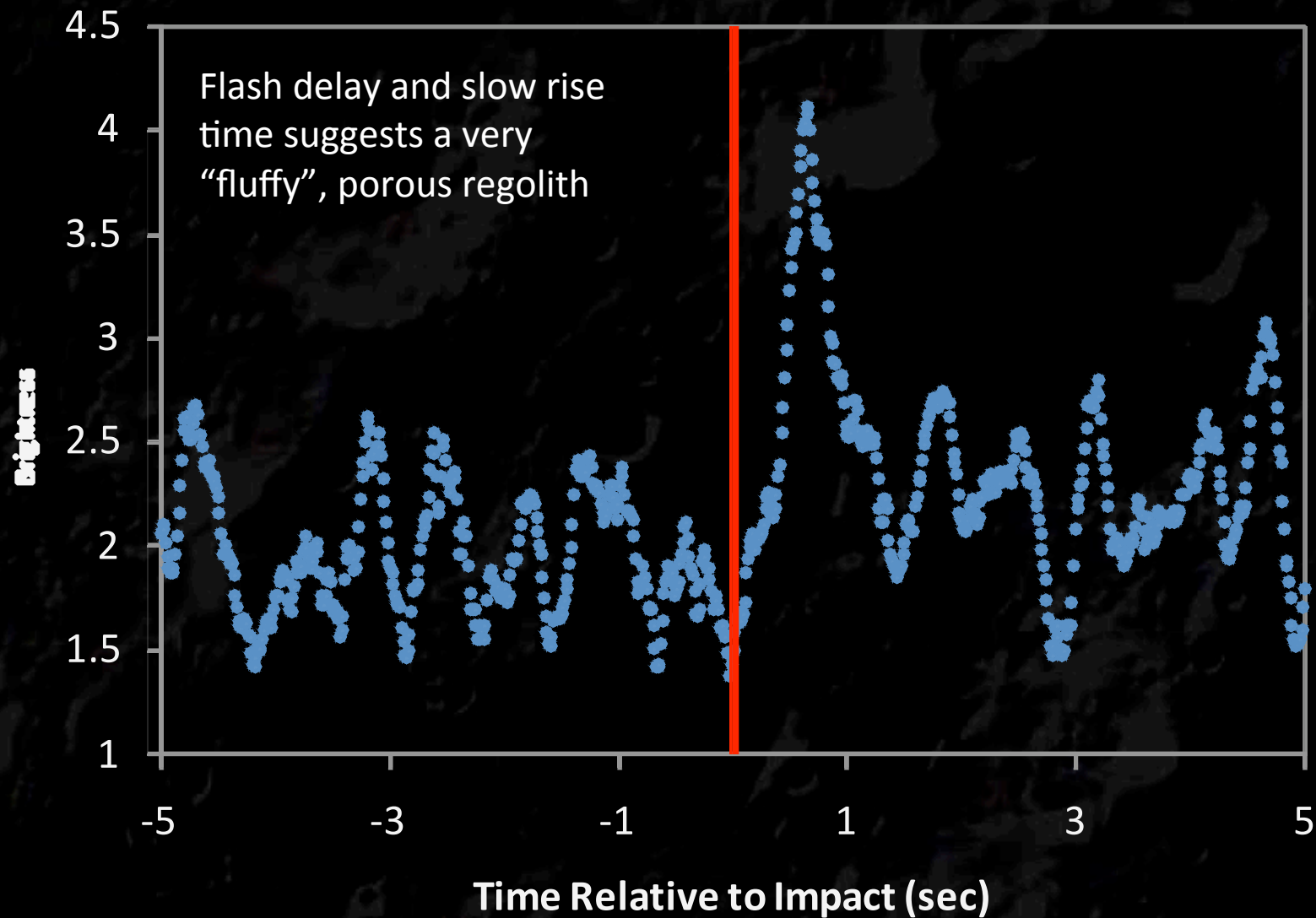
- Obvious hydrogen, but worst Earth observing

LCROSS Visible Camera



Impact Flash

NIR Flash Measurements





Dr. Colaprete's iChart

CAN
YOU SEE

T H E P L U M E N O W

D I D Y O U T R Y I N F R A R E D



Thermal Camera Images of Impact



SSC range about 600 km



Thermal Camera Images of Impact



Impact + 1 sec

+ 3 sec

+ 5 sec

+ 7 sec

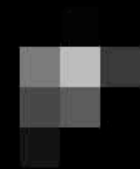
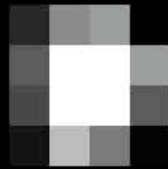
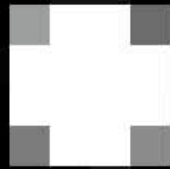
1px = 1.01145 km

1px = 1.007723 km

1px = 1.00401 km

1px = 1.000291 km

6 km



+ 9 sec

+ 11 sec

+ 13 sec

+ 15 sec

1px = 0.996574 km

1px = 0.992857 km

1px = 0.989138 km

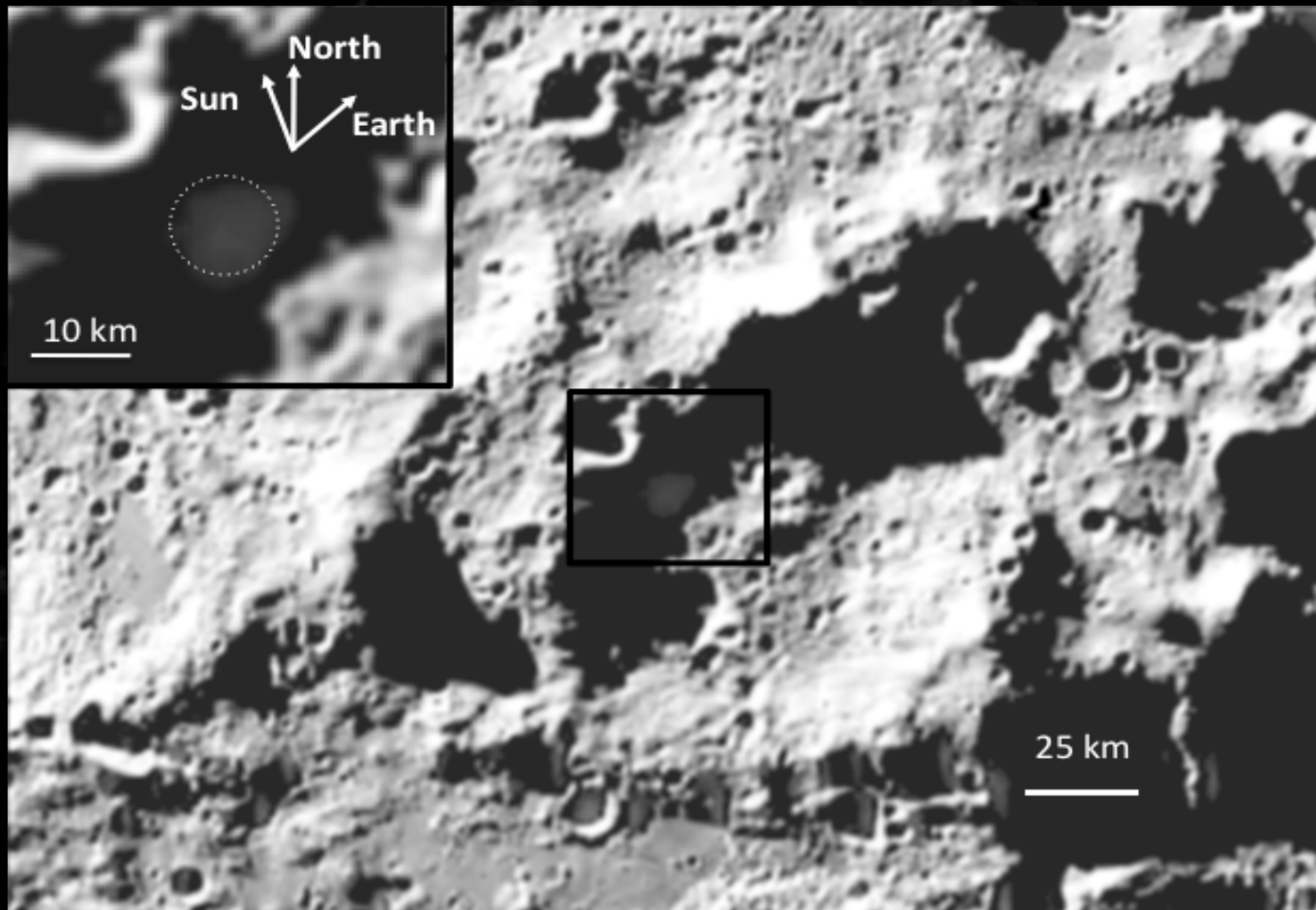
1px = 0.985418 km





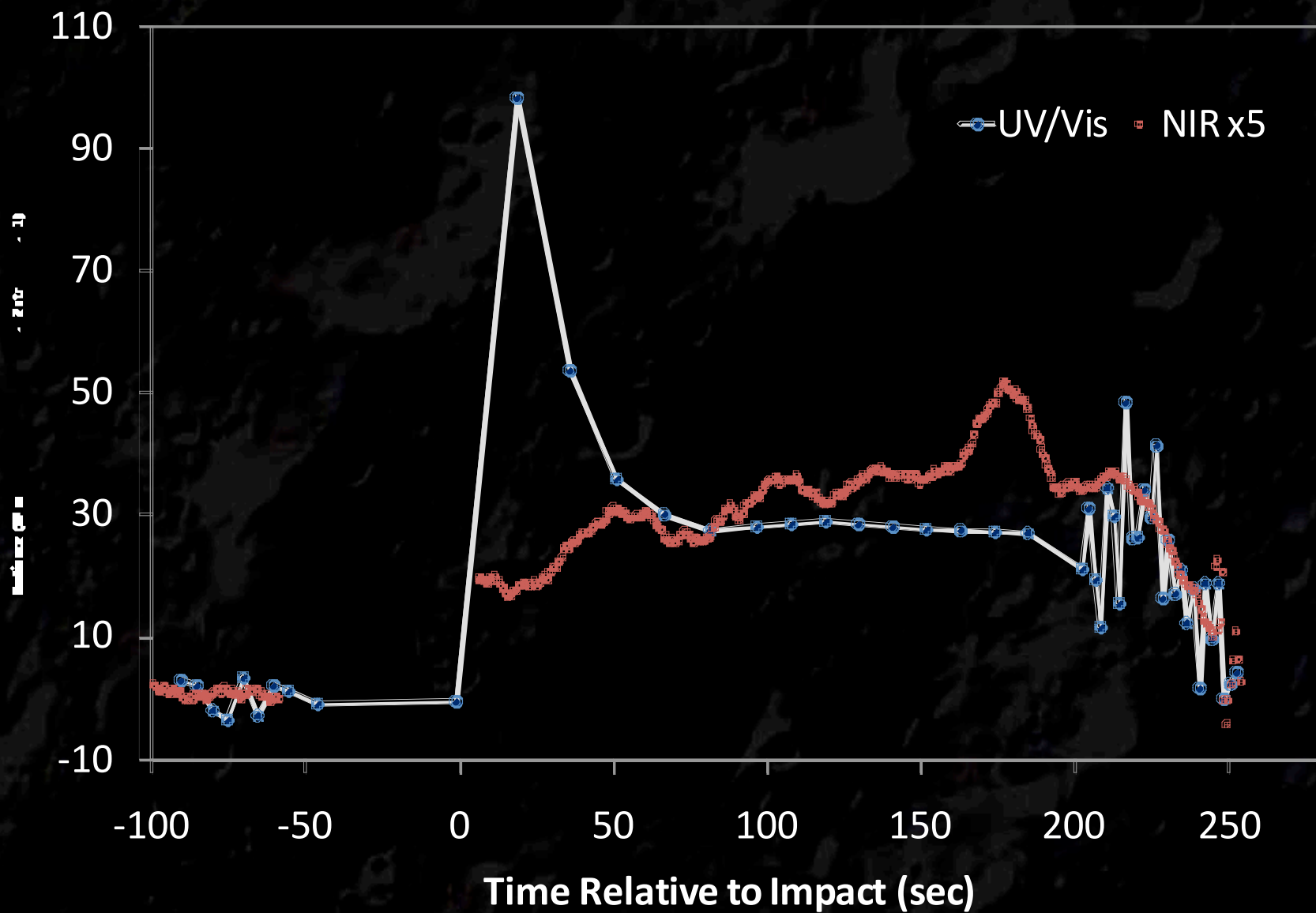
Impact Observations

LCROSS Visible Camera Image of Ejecta Cloud





Total Radiance from Ejecta

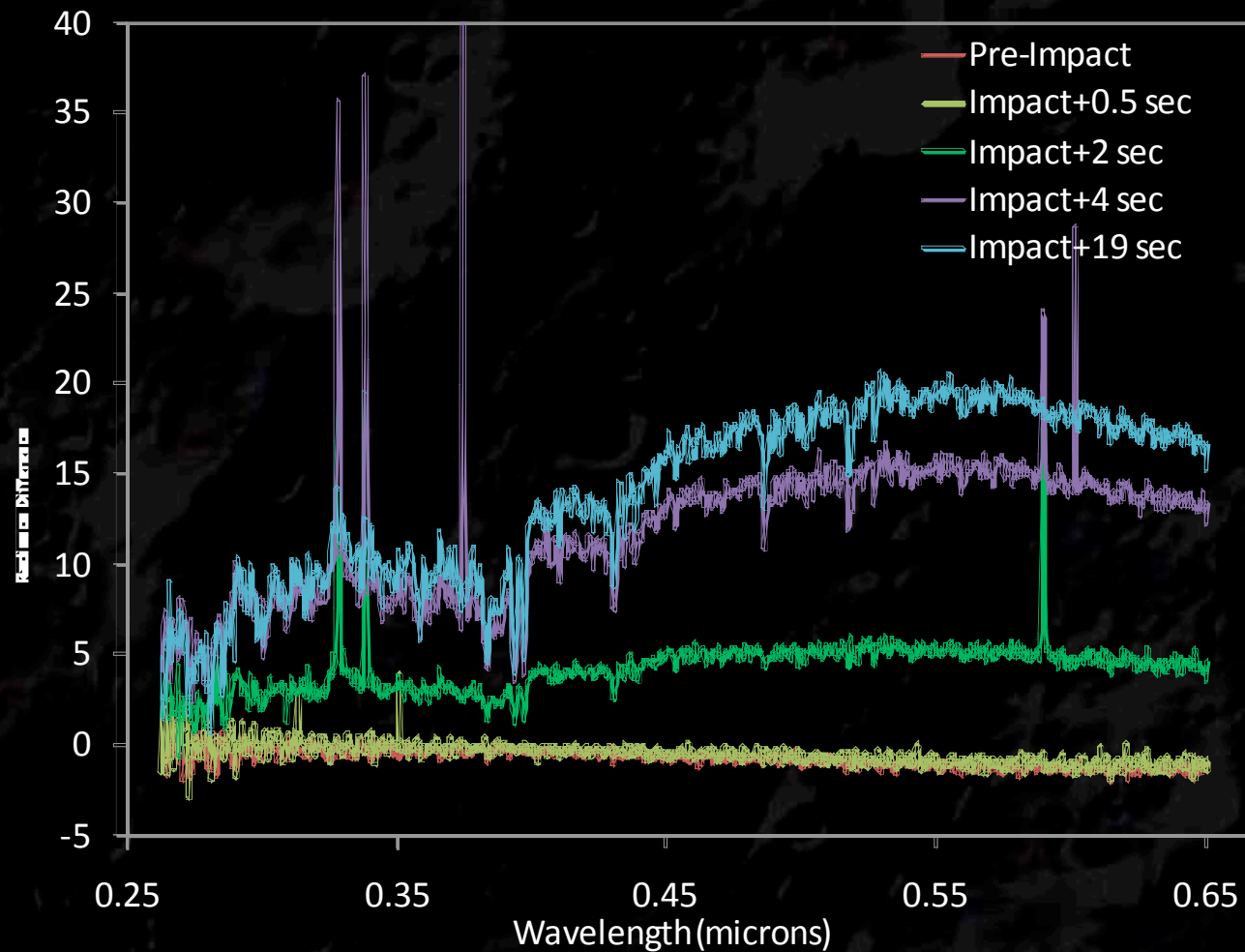




UV/Visible Just after Impact

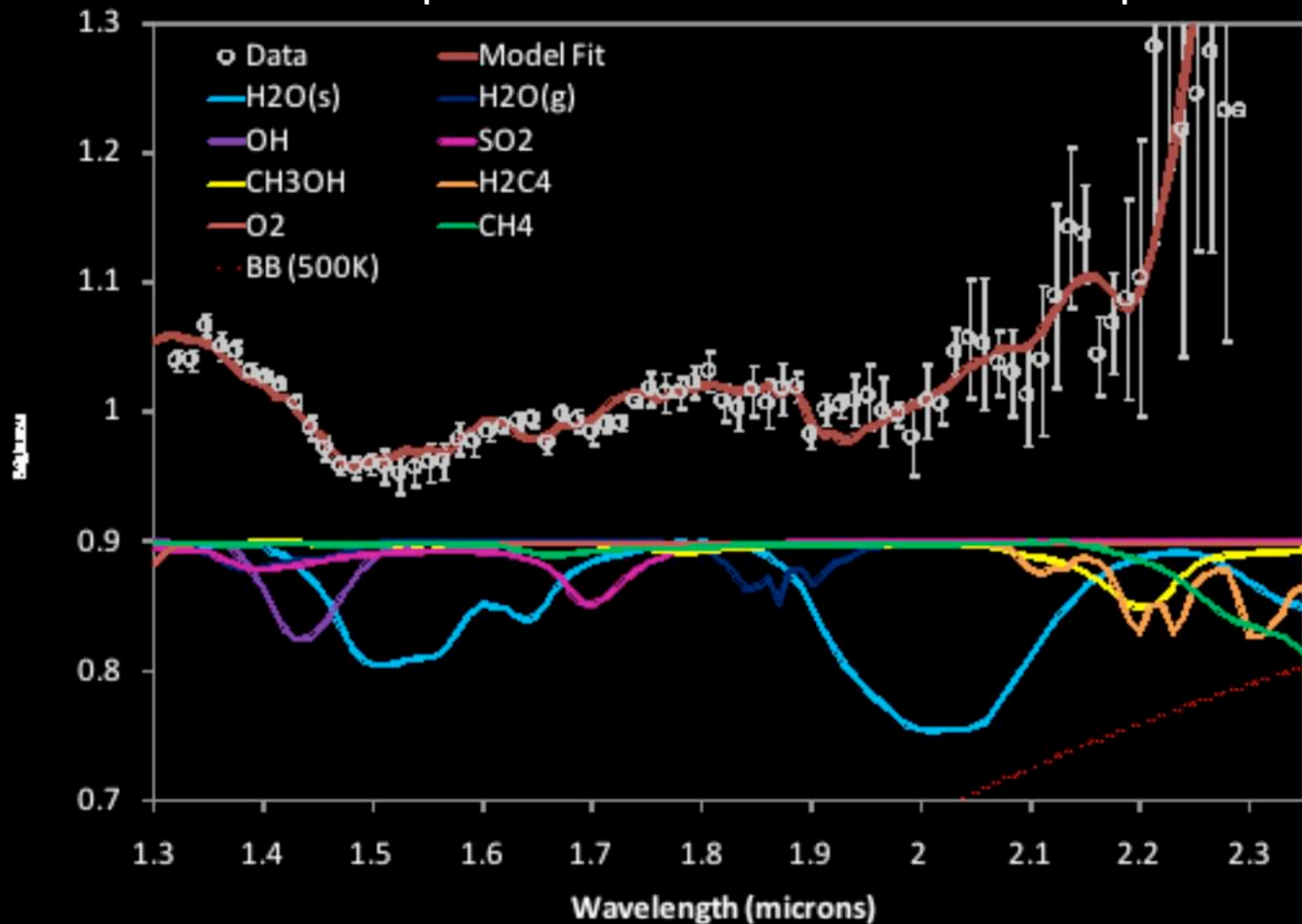
UV/Visible Observations Just After Impact

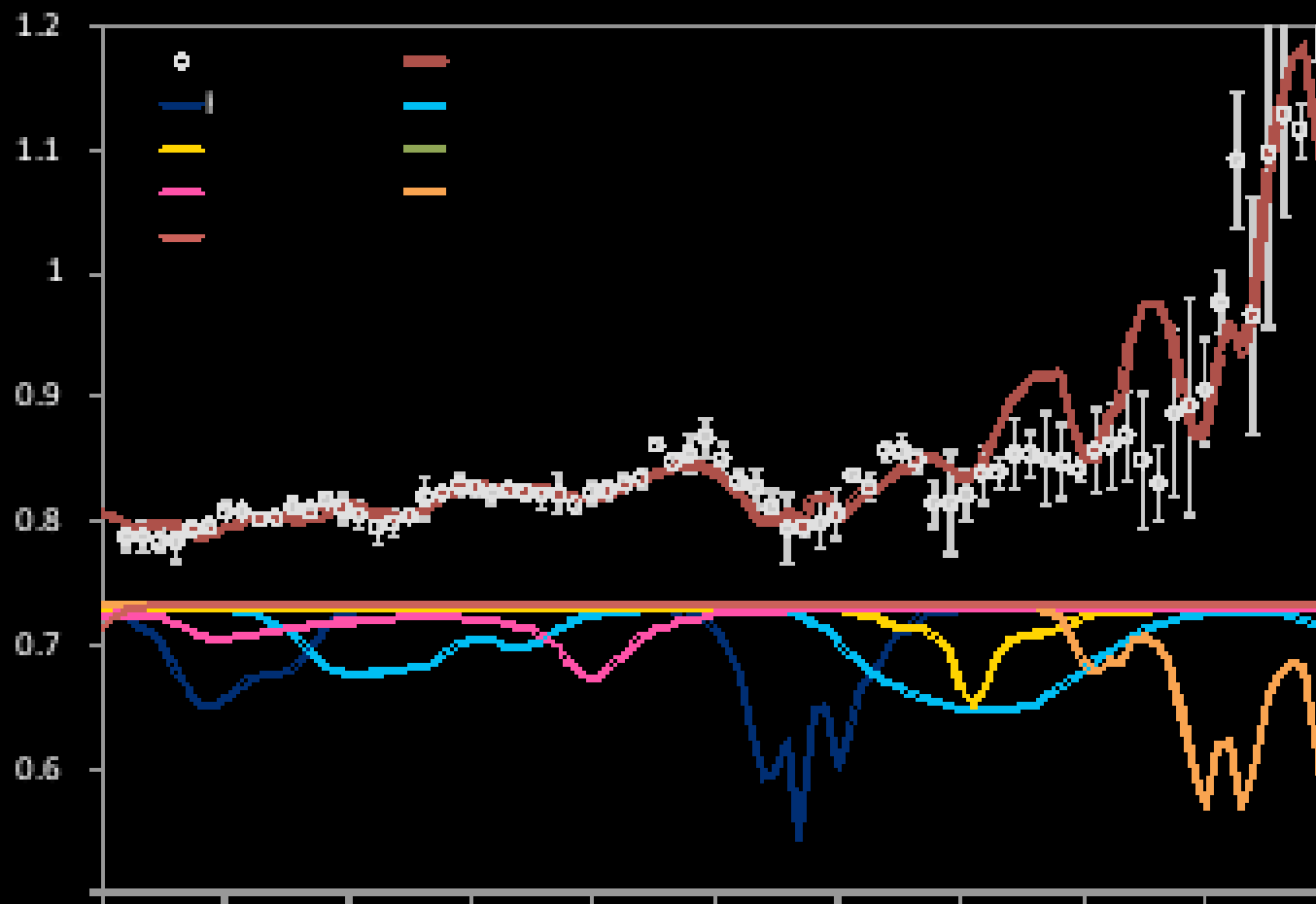
Observations used for species identification and ejecta grain characterization



Fits to NIR Spectra

Nadir NIR spectrometer: 24-30 sec after impact

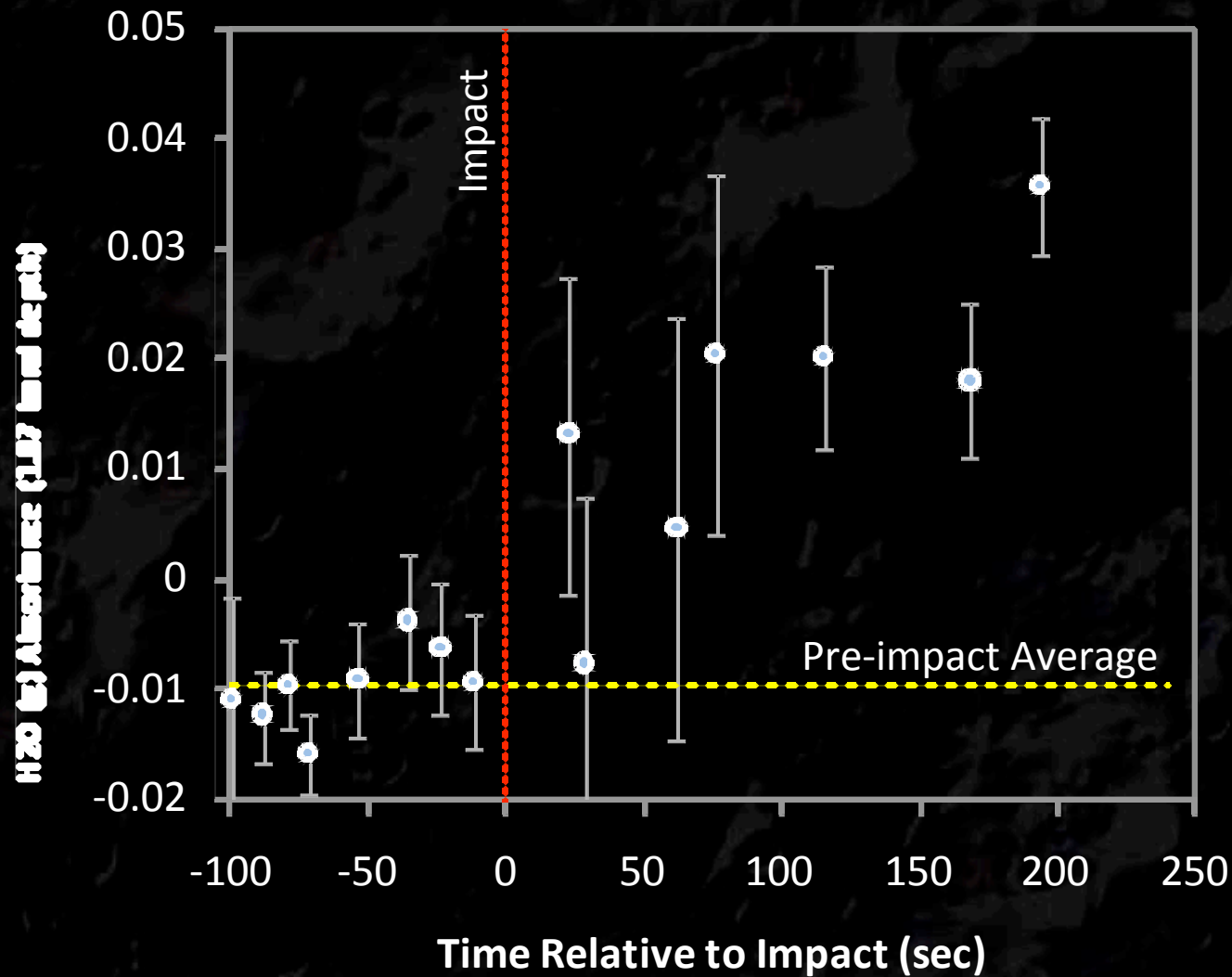






Fits to NIR Spectra

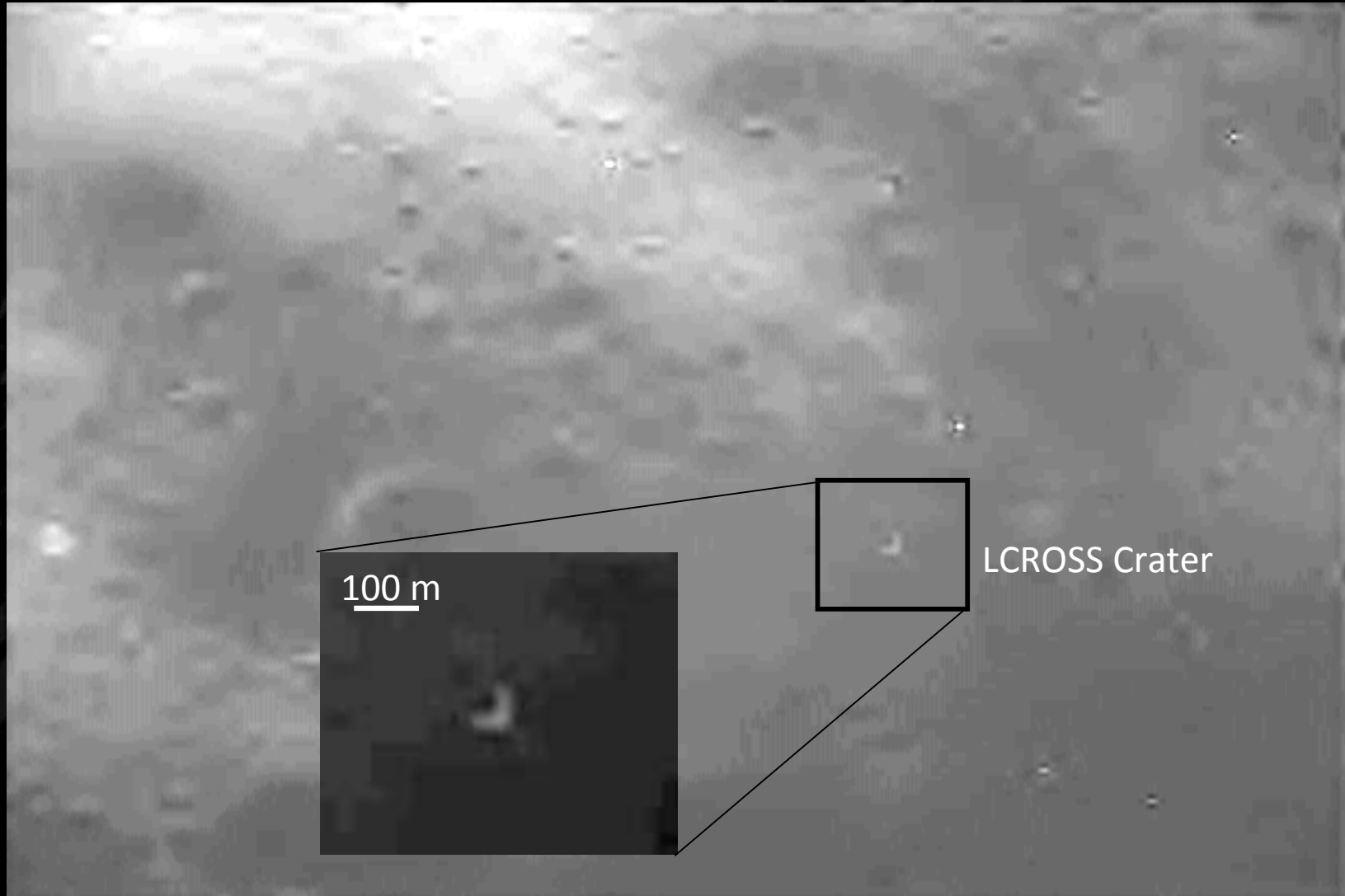
Water Vapor After Impact





Centaur Crater Observations

LCROSS NIR Camera image from about 14 km above surface





Impact Observations

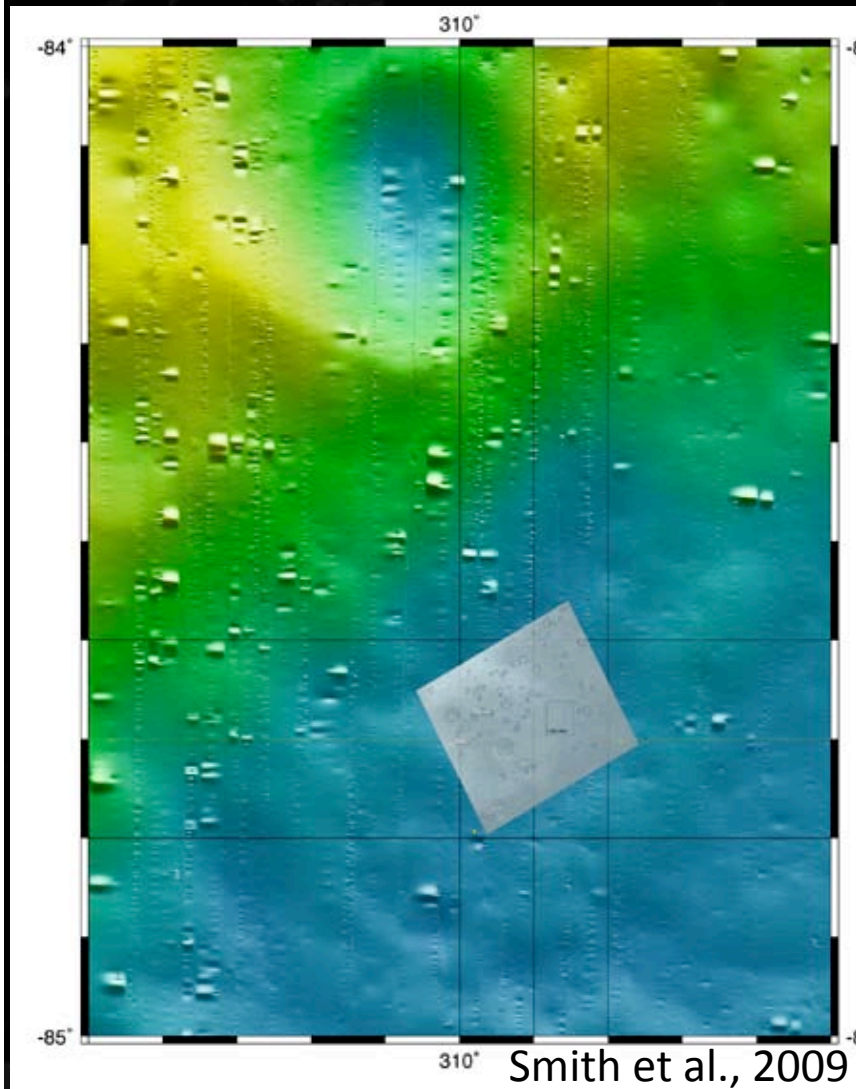
LCROSS MIR Camera image from about 5.6 km above surface

~10 m/pixel

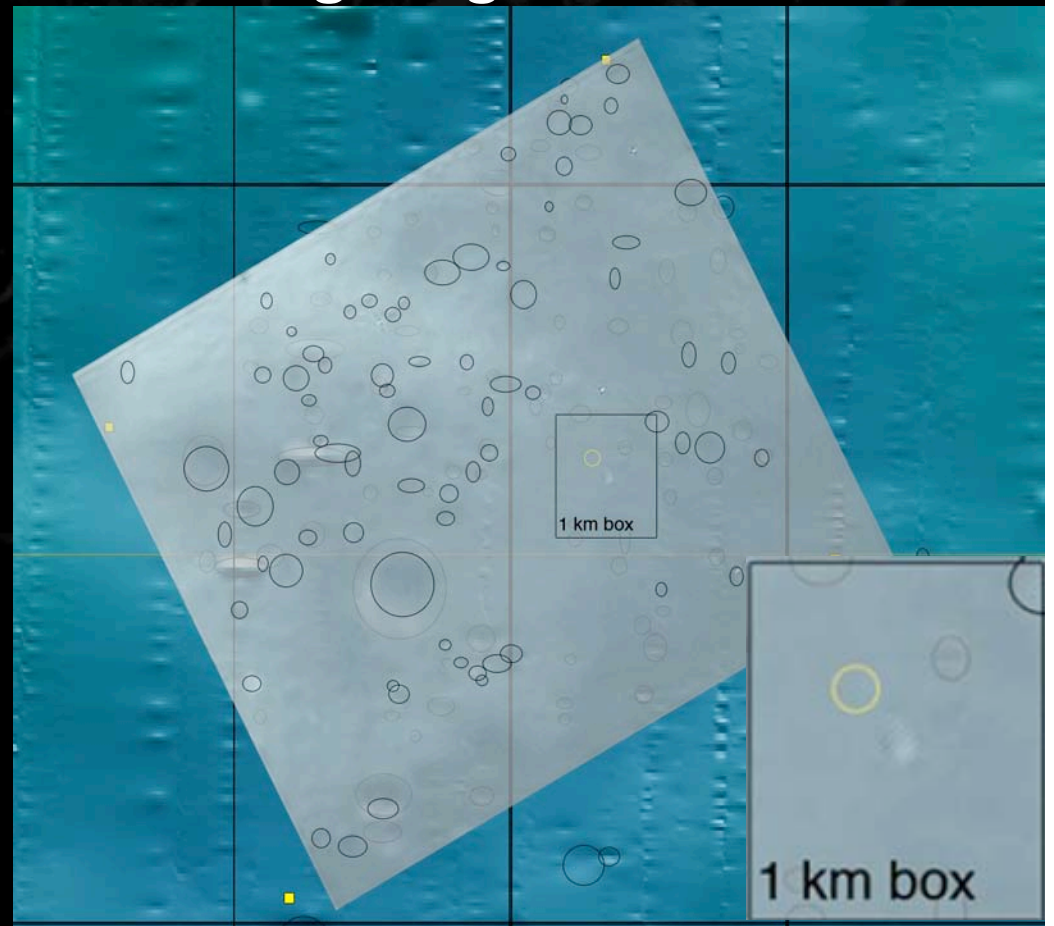




Final Resting Place of Centaur



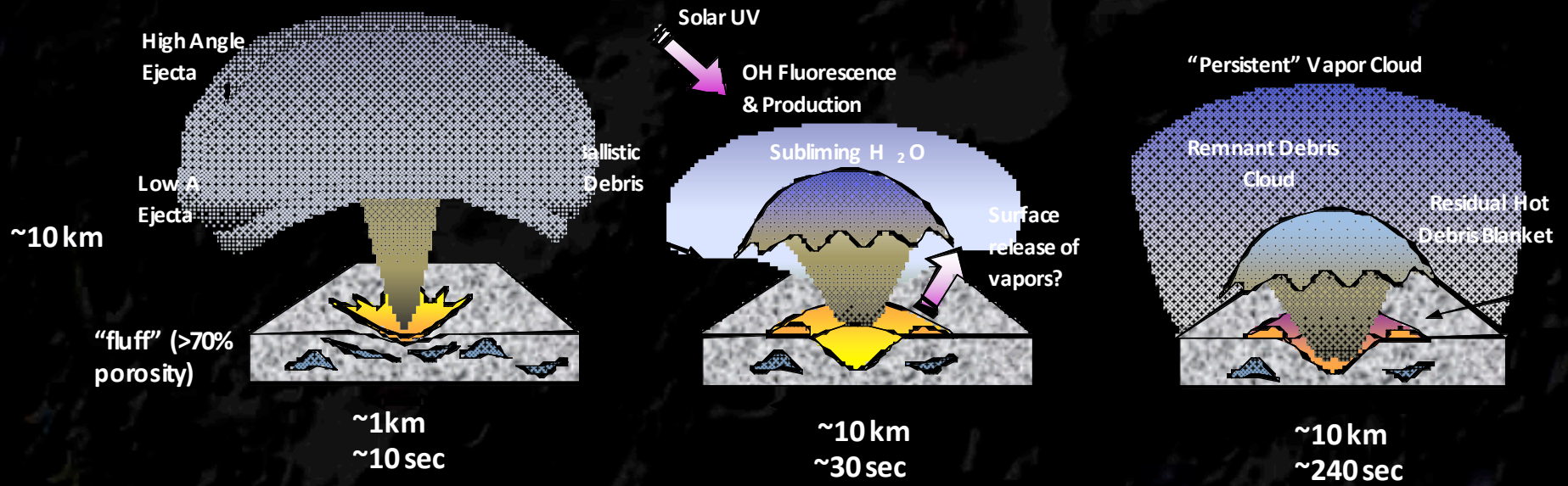
NIR2 image registered to LOLA



Hit within $83 \text{ m} \pm 66 \text{ m} (1\sigma)$
of planned target



Impact Summary



Cabeus represents a new environment:

- Exceedingly cold temperatures trap all sorts of volatiles...but it doesn't end there
- Enough energy (radiation and electric fields?) to move grain surface chemistry
- A new environment, but maybe not unique, as similar conditions may exist on a number of other airless bodies



The LCROSS Experiment: Smooth or Chunky?

Evenly Distributed, low concentrations
“Smooth”



Higher, infrequent concentrations
“Chunky”



Processes such as impacts, diffusion, topography and sputtering may effect the distribution at a variety of scales



Thank You